WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

PCT

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B08B 9/04

A1

(11) International Publication Number: WO 00/30773

(43) International Publication Date: 2 June 2000 (02.06.00)

(21) International Application Number: PCT/GB99/03907

(22) International Filing Date: 24 November 1999 (24.11.99)

(30) Priority Data: 9825714.0 24 November 1998 (24.11.98) GB

(71) Applicant (*for all designated States except US*): HAMDEEN LIMITED [GB/GB]; Birkdale House, 7 Myrtle Street, Douglas, Isle of Man IM1 4ED (GB).

(72) Inventor; and

(75) Inventor/Applicant (*for US only*): LAKER, Keith [GB/–]; 1 Piersteps, St Peter Port, Guernsey GY1 2LF (GB).

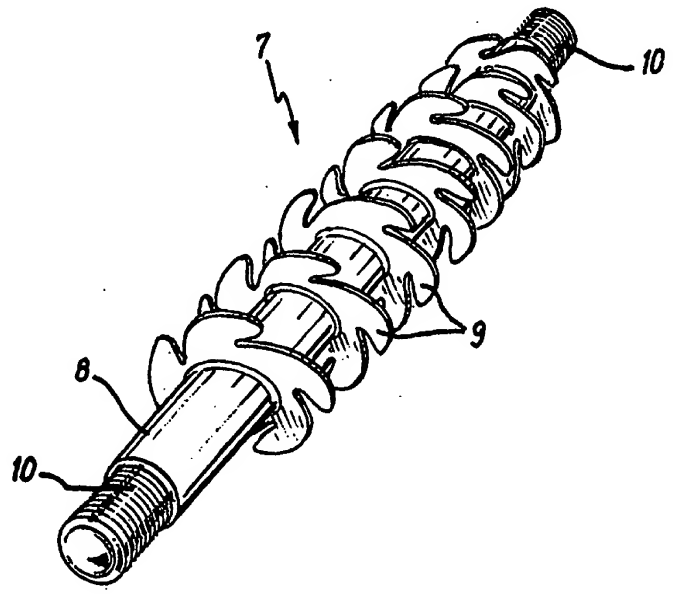
(74) Agent: KENNEDY & CO.; Queens House, 4th floor, 29 St Vincent Place, Glasgow G1 2DT (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: PIPELINE PIG



(57) Abstract

A pig (1) for use with a tubular bore wherein the pig (1) is comprised of a body (2) which supports a plurality of turbine blades (3) wherein the blades (3) mechanically break down and remove debris from the tubular bore. The blades (3) have a profile which allows forward movement and rotation about a longitudinal axis when acted upon by a propulsion fluid travelling through the tubular. In an alternative embodiment the blades are mounted on a stabiliser body to allow simultaneous centralisation and cleaning.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

PIPELINE PIG

This invention generally relates to mechanical pigging devices, commonly referred to simply as "pigs", for use in pipelines or other tubulars. Such pigs are known to find utility in a diverse range of applications, including for cleaning purposes and for conveying equipment in the case, for example, of pipeline monitoring. In the present invention there is described a unique pig suitable for use in the cleaning of internal surfaces of a pipeline or tubular and, in a variation thereof, suitable for applying coatings or other fluids to the aforesaid surfaces.

It is known in the art to cause cleaning pigs to be propelled through a pipe or tubing under the influence of a pressurised fluid. Pigs, designed for this purpose, typically have a flexible cylindrical body made, for example, from a polyurethane foam. Other materials have also commonly been used, including rubber, metal, plastics and combinations and composites. The rear and front end walls of the cylindrical body may be covered with an impervious coating designed to form a moving seal with the inner wall of the pipe. With this design, the pig essentially acts as a piston as it is conveyed through the pipeline or tubular; the fluid on its rear side having a higher pressure head than the fluid at its front side.

Notably, pigs propelled through pipelines or the like in the manner described above are intended to prevent propelling fluid from flowing through or around the pig. Implicated by this, pigs used for cleaning purposes have, in the past, been intended to physically push and

forceout debris in advance of the pig as it travels through the pipe bore. At best, the pig itself provides an additional wiping function on the pipe walls.

In the present invention it is recognised that, on occasion, it would be advantageous to provide a more rigorous cleaning process to a pipeline bore than merely pushing loose debris and wiping the surfaces. In the art, those who have addressed this problem have contemplated the provision of scratching elements, such as wire bristles, on the circumferential walls of the pig. While related designs provide for a more aggressive cleaning process, such pigs usually do not allow for sufficient fluid flow past the bristles to allow for the bristles themselves to be cleaned. In use, debris, shavings, slivers and the like can become lodged between the bristles, serving to reduce the efficiency of the pig's travel and the cleaning process.

An object of the present invention is to obviate or at least mitigate these and other disadvantages associated with pipeline or tubular cleaning pigs. In one aspect, the invention seeks to achieve this by creating an alternative means for the propulsion of the pig through the pipeline or other tubular.

A further object of the invention herein is to employ the novel propulsion features disclosed herein in relation to pigs for use in respect of other functions, including pigs intended to act as mechanical applicators.

According to a first aspect of the present invention there is provided a pig for use in a tubular bore, wherein the pig is provided with one or more blades

having a profile that encourages both forward movement and rotation about a longitudinal axis of the pig when acted upon by a propulsion fluid travelling through the tubular.

It is envisaged that the pig may comprise of a cylindrical elongate body having an outer diameter less than the internal diameter of the tubular, wherein the body supports a plurality of blades.

Preferably, the pig is a cleaning pig and the peripheral edges of the blades are adapted to perform a cleaning function as the pig rotates and travels through the tubular. More particularly, the blades of the pig are designed to scrape the internal surfaces of the tubular bore upon the rotation and passage of the pig. An advantage may be obtained in the option of providing the edges in an abrasive material. Similarly, the edges of the blades may be provided in a material that is relatively hard and therefore resistant to wear.

Preferably the blades are provided in composite, such as kevlar, carbon, glass fibre, although any other suitable material may be used.

Alternatively, however, the peripheral edges may be adapted to perform alternative functions. For example, the pig may be provided as a means for the mechanical application of a coating or fluid to a tubular bore and, optionally, the blades or at least the edges thereof may support a suitable applicator material having a high capacity for carrying by absorption or other means the coating or fluid to be applied.

According to a second aspect of the present invention there is provided a pig for use in a tubular, wherein the pig is comprised of a stabiliser body wherein the stabiliser body supports a plurality of blades and is conveyed mechanically through a tubular.

Preferably the pig is a cleaning pig wherein the blades of the pig are designed to scrape the internal surfaces of the tubular bore whilst the stabiliser body provides centralisation.

Preferably the blades may be adapted so that they do not exhibit any abrasive qualities thereby reducing the risk of damage if the pig is to be used in tubing which is plastic coated.

Preferably the blade properties can be pre selected to be adapted to flex through a profiled restriction in the tublar bore thereby providing a means of confirming the position of a pig within the tubulars.

According to a third aspect of the present invention there is provided a pig for use in a tubular, wherein the pig is adapted to rotate in its longitudinal axis under the influence of a propulsion fluid as it is displaced through the tubular.

The pig may be further adapted to rotate in orbit within the tubular bore.

According to a fourth aspect of the present invention there is provided a pig for use in a tubular, the pig comprising reaction surfaces adapted for forward propulsion of the pig under the influence of a positive pressure applied by propulsion fluid travelling through

the tubular, characterised in that the reaction surfaces are spaced and orientated so as to provide for a net positive velocity of the propulsion fluid relative to the pig in the direction of travel through the tubular.

The reaction surfaces may be provided on a plurality of respective blades, such as turbine blades. Preferably, the blades define a fluid by-pass path, the blades being separated by void areas which permit the relative flow of fluid through the pig in a forward direction.

Preferably the reaction surfaces also encourage the rotation of the pig around its longitudinal axis when acted upon by the propulsion fluid.

According to a fifth aspect of the present invention there is provided a pig for use in a tubular, wherein the pig is provided with one or more blades having a profile that precludes rotation of the pig while travelling through the tubular.

The blades are typically of varying diameter, the largest blade or blades potentially, having a diameter greater than the internal diameter of the tubular.

Preferably the largest blade or blades are sufficiently flexible to allow entry and passage of the pig through the tubular yet sufficiently robust to carry out and withstand the rigours of the cleaning process.

It should be understood that references to tubulars herein, unless the context otherwise dictates, should be construed in the broadest possible sense, and interpreted to encompass any form of tubing, pipe or pipeline.

In order to provide a better understanding of the invention, example embodiments of a pig incorporating the invention will now be described with reference to the accompanying Figures;

Figure 1 shows, in perspective view, a pig intended for the cleaning of the internal surfaces of coiled tubing as the pig is propelled along the tubular by a propulsion fluid.

Figure 2 shows, in perspective view, a pig intended to provide stabilisation and cleaning of the internal surfaces of tubing as the pig is conveyed mechanically along a tubular.

Referring firstly to Figure 1, a pig, generally depicted at 1, comprises substantially of a body 2 and a plurality of turbine blades 3. The body 2 is generally elongate and cylindrical. The pig body 2 is suitably made of a robust material in view of its need to withstand substantial impact loads, while also functioning in an aggressive cleaning manner.

The blades 3 are afforded a turbine or impeller like profile, having reaction surfaces 4 that react to the influence of a propulsion fluid pumped through the coiled tubing in which the pig 1 is intended to travel. Typical of turbine blades, the blades 3 can be provided on the body 2 such that the reaction surfaces 4 are presented at an acute angle to the linear direction of the fluid flow, thereby imparting a reaction torque to the body 2 in addition to a reaction force in the axial direction. In consequence, the pig 1, when acted upon by a propulsion fluid, is caused to travel through the coiled tubing in a

generally axial direction, but to also rotate about its longitudinal axis while so doing.

Additionally, the pig 1 moves in a third dynamic path. The outside diameter of the pig 1 can be sized to have a degree of clearance within the internal bore of the tubular. That is to say, the maximum outside diameter of the pig is less than the internal diameter of the tubular, allowing for radial displacement of the pig 1 during its travel through the tubing. In fact, it is recognised in the present invention, that such dimensioning of the pig 1 relative to the tubing causes the longitudinal axis of the pig 1 to orbit or rotate about the substantially parallel longitudinal axis of the tubing.

This third dynamic path is associated with a number of advantages. For instance, where it is intended that the peripheral edges 5 of the blades 3 contact the internal surfaces of the tubing, the radial displacement of the pig 1 as it orbits around the longitudinal axis of the tubing allows for such contact over a range of tubing diameters. This means that it is not essential that a respective pig, incorporating the invention hereto, need be provided to correspond to each size of coiled tubing or other tubular.

In an alternative application a pipeline can be cleaned using a combination of two pigs. The first pig, having an outer diameter less than the internal diameter of the tubular, passes through the pipeline removing major restrictions. The second pig removes additional debris and in effect polishes the internal surface of the pipeline.

A further advantage, which applies also to the other rotational movement of the pig about its own axis, is that the relative velocity of the blade edges 5 is considerably higher relative to the tubing surfaces than that of a pig merely designed for linear movement. This is particularly advantageous where the pig is intended for use as a mechanical cleaning device.

The cleaning pig 1 is designed to clean the internal bore of coiled tubing. More particularly, the pig 1 is adapted to apply a rotational cleaning action suitable for removing scales and other deposits located on the internal surfaces of the tubing.

In one use, the pig may be used to prepare the surface of a tubular, by removing scale or rust not removed by other cleaning methods, prior to the application of a coating fluid or material.

Secondary cleaning of the coiled tubing is achieved by the effects of disturbances in the flow of the propulsion fluid through the voids between the turbine blades 3.

The interaction of the turbine blades with the propulsion renders the propulsion fluid flow of a turbulent nature. It will be appreciated by those skilled in the art that this enhances the cleaning efficiency of the device.

Furthermore, the presence of voids between the blades 3 results in the propulsion fluid having a positive velocity relative to the pig. As a consequence of this positive velocity the propulsion fluid also removes the debris created by the cleaning of the coiled tubing. The

removal of this debris has the advantage of preventing the build up of potential blockages in the coiled tubing. Moreover, debris is also cleaned from the blades of the pig itself.

In an alternative embodiment the reaction surfaces 4 and most particularly peripheral edges 5 of the blades 3 are provided with a material suitable for the application of a coating of other fluid material.

With reference to Figure 2, an alternative embodiment of the present invention generally depicted at 7 comprises a stabiliser body 8 which has a plurality of blades 9 mounted in a similar configuration to the embodiment shown in figure 1. The stabiliser body 8 has coupling means 10 which allow attachment to mechanical driving means (not shown) so that the stabiliser body 8 is propelled through a tubular. Where the tubular is casing or liner in a well-bore, the mechanical driving means may be a pipe string, for example. Furthermore the blades 9 are mounted on the stabiliser body 8 in a watermelon shaped configuration which assists entry into and retrieval out of profiled restrictions.

In this manner the embodiment shown in Figure 2 allows simultaneous centralisation and cleaning for coiled tubing.

Further modifications and improvements may be incorporated without departing from the scope of the invention herein intended.

Claims:

1. A pig for use with a tubular bore, wherein the pig is provided with one or more blades having a profile that encourages both forward movement and rotation about a longitudinal axis of the pig when acted upon by a propulsion fluid travelling through the tubular.

2. A pig as claimed in Claim 1 wherein the pig is comprised of a cylindrical elongate body having an outer diameter substantially less than the internal diameter of the tubular, wherein the body supports a plurality of blades.

3. A pig as claimed in any one of the preceding Claims wherein the blades are designed to scrape the internal surfaces of the tubular bore upon rotation and passage of the pig.

4. A pig as claimed in any of the preceding Claims wherein the pig may be adapted to act as a means for the mechanical application of a coating or a fluid to a tubular bore.

5. A pig as claimed in any one of the preceding Claims wherein the blades are afforded a turbine or impeller like profile and have reaction surfaces adapted for the forward propulsion of the pig under the influence of a positive pressure applied by propulsion fluid travelling through the tubular.

6. A pig as claimed in any one of the preceding Claims wherein the blade design allows sufficient fluid by-pass to allow the debris removed from the tubular bore and suspended in the pumped fluid to be flushed ahead of the pig.

7. A pig as claimed in any one of the preceding Claims wherein the blades are shaped in such a manner that they are separated by void areas which permit the relative flow of fluid through the pig in a forward direction.

8. A pig as claimed in any one of the preceding Claims wherein the blades are of varying diameter.

9. A pig as claimed in any one of the preceding Claims wherein the largest blade has a diameter greater than the internal diameter of the tubular.

10. A pig as claimed in Claim 9 wherein the largest blade is sufficiently flexible to allow entry and passage of the pig through the tubular.

11. A pig for use with a tubular bore, wherein the pig is comprised of a stabiliser body having means for connection to a mechanical driving means, which supports a plurality of blades, each blade having a fixed diameter, wherein the combination of blades have a watermelon shaped profile.

12. A pig as claimed in Claim 11 wherein said pig provides simultaneous centralisation and scraping of

the internal surfaces of a tubular as the pig is conveyed mechanically through the tubular.

13. A pig as claimed in Claims 11 and 12 wherein the blade properties are selected to be adapted to flex through a profiled restriction in the tubular bore thereby providing a means of confirming the position of the pig within the tubulars.

14. A pig as claimed in any of the preceding Claims wherein the blades are provided in a material that is relatively hard and resistant to wear.

15. A pig as claimed in any of the preceding Claims wherein the blades are manufactured from composite, such as kevlar, carbon or glass fibre.

16. A pig as claimed in any one of the preceding Claims supported on a pipe string in a well-bore.

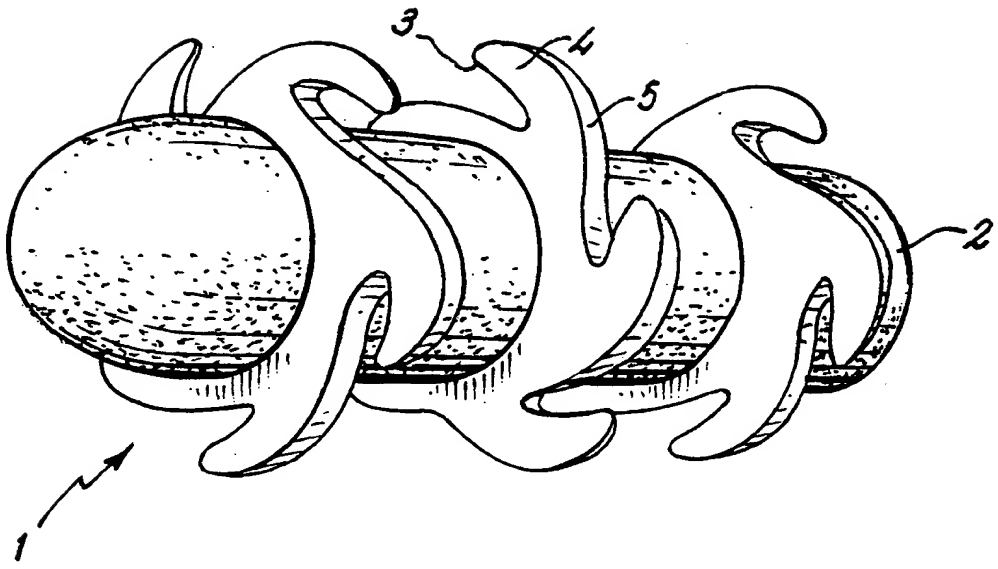


FIG.1

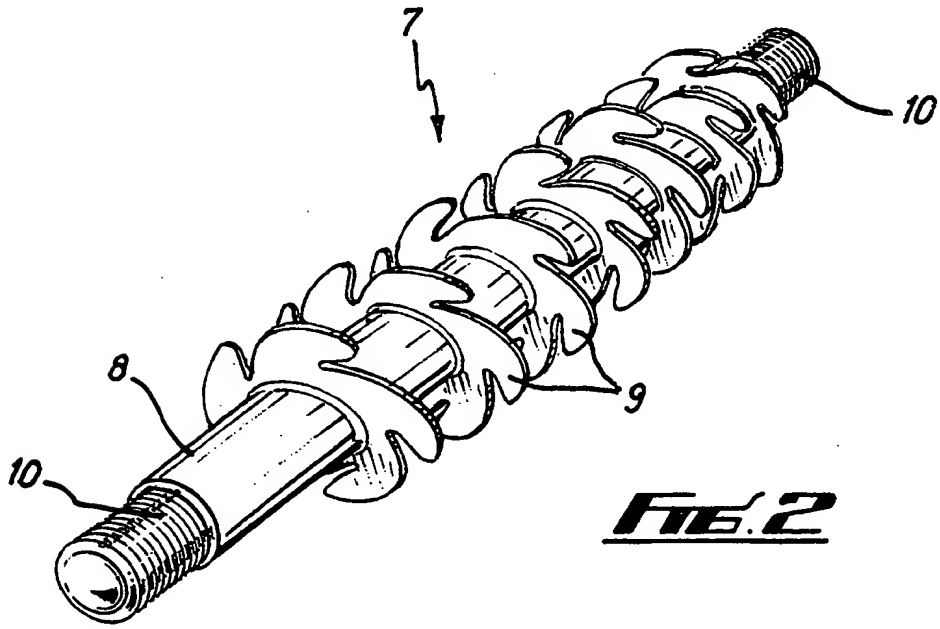


FIG.2

INTERNATIONAL SEARCH REPORT

Int. Application No
PCT/GB 99/03907

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B08B9/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16L B08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 081 875 A (NISHINO EIZO) 4 April 1978 (1978-04-04) the whole document	1,2,5-7
A		3,9,10, 14,15
X	DE 29 44 709 A (RUHRKOHLE AG) 14 May 1981 (1981-05-14) page 6, paragraph 2 figures 2,3	1-3,5,11
A		6-8,14, 15

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 March 2000	17/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax (+31–70) 340–3016	Schaeffler, C

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 379 475 A (SIVACOE ORLANDE) 10 January 1995 (1995-01-10) abstract figure 4 column 2, line 33 - line 65 column 3, line 14 - line 25	1-3,6,7, 12-14
A	US 5 600 863 A (CURRAN ED) 11 February 1997 (1997-02-11) abstract figure 1 column 3, line 21 - line 42 claim 1	1,3,5,6, 10
A	US 4 122 575 A (SAGAWA TEIKICHI) 31 October 1978 (1978-10-31) figures 1A,1D column 3, line 35 - line 43	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. Application No
PCT/GB 99/03907

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4081875 A	04-04-1978	NONE	
DE 2944709 A	14-05-1981	CH 649011 A	30-04-1985
US 5379475 A	10-01-1995	CA 2099794 A	06-01-1995
US 5600863 A	11-02-1997	US 5528790 A	25-06-1996
US 4122575 A	31-10-1978	NONE	